HEWLETT **hp** PACKARD

INSTALLATION MANUAL

12895A

DIRECT MEMORY ACCESS
COMPUTER ACCESSORY KIT

(FOR THE 2100A COMPUTER)

Card Assembly
12895-60001, All Revisions

Note

Retain this manual with the Installation and Maintenance Manual supplied with the computer.

1. INTRODUCTION.

2. This manual provides field installation instructions for the 12895A Direct Memory Access Computer Accessory Kit, an accessory for the Hewlett-Packard 2100A Computer. Further information about the accessory is provided as follows: For theory of operation and maintenance information, refer to the Installation and Maintenance Manual for the computer; for schematic and component location diagrams, refer to the computer Diagrams Manual; for replacement parts information, refer to the computer Illustrated Parts Breakdown Manual; for a description of programming requirements and a sample assembly language program, refer to the computer Reference Manual.

3. DESCRIPTION.

4. The direct memory access (DMA) accessory kit enables high-speed data transfers between computer memory and any peripheral device normally serviced through the computer input/output system. Data is transferred in blocks of 16-bit words; block size can be any number between one and a number equal to the memory size of the computer. Maximum transfer rate is 1,020,000 16-bit words per second.

5. The accessory kit includes one DMA printed-circuit card, part number 12895-60001, and one installation manual, part number 12895-90001.

6. UNPACKING AND INSPECTION.

7. If the shipping container is damaged upon receipt, request that the carrier's agent be present when the equipment is unpacked. Inspect the card for damage (scratches, cracks, loose components, etc.). If the card is damaged and fails to meet specifications, notify the carrier and the nearest HP Sales and Service Office immediately. (HP Sales and Service Offices are listed at the back of this manual.) Retain the shipping container and the packing material for the carrier's inspection. The HP Sales and Service Office will arrange for the repair or replacement of the damaged equipment without waiting for any claims against the carrier to be settled.

8. IDENTIFICATION.

9. Printed-circuit card revisions are identified by a letter, a date code, and a division code stamped on the card (e.g., A-1103-22). The letter code identifies the version of the etched trace pattern on the unloaded card. The date code (four middle digits) refers to the electrical characteristics of the loaded card. The division code (last two digits) identifies the Hewlett-Packard division that manufactured

the card. If the date code stamped on the printed-circuit card does not agree with the date code shown on the appropriate schematic diagram in the computer Diagrams Manual, there are differences between your card and the card described in the Diagrams Manual. These differences are described in manual supplements available at the nearest HP Sales and Service Office.

10. INSTALLATION.

11. Install the DMA card in the computer as follows (refer to figure 1):

a. Halt computer and turn power switch off.

b. Remove top access cover from computer.

c. Remove card retainer.

d. Insert DMA card in slot 9. Be sure that components face left when card is viewed from front of computer.
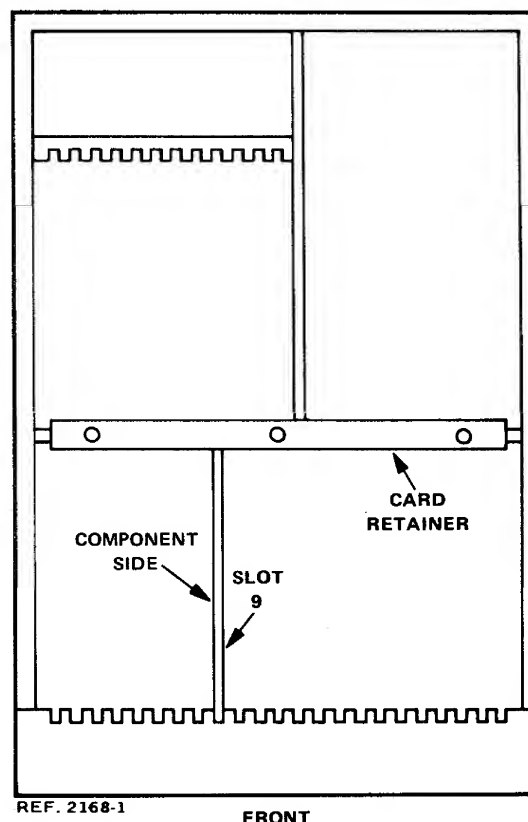
e. Reinstall card retainer and computer top access cover.

REF. 2168-1   FRONT

Figure 1. Installation Details

12. INSTALLATION CHECKOUT.

13. After installing the DMA card, verify proper operation by performing the DMA diagnostic test. The Diagnostic Program Procedure, part number 12578-90014, provides operating procedures for the test.

14. MAINTENANCE.

15. If the results of the diagnostic test indicate that the DMA accessory does not operate properly, refer to the 2100A Computer Installation and Maintenance Manual, part no. 02100-90002, for maintenance information pertaining to the DMA card.

16. SHIPPING AND STORAGE.

17. If the card from the kit is to be shipped to Hewlett-Packard for service or repair, attach a tag to the card identifying the owner and indicating the service or repair to be accomplished. Include the number of the kit.

18. Package the card in the original factory packaging material, if available. If the original material is not available, standard factory packaging material can be obtained from a local Hewlett-Packard Sales and Service Office.

19. If standard factory packaging material is not used, wrap the card in Air Cap TH-240 cushioning (or equivalent) manufactured by Sealed Air Corp., Hawthorne, N.J., and place in a corrugated carton (200 pound test material). Seal the shipping carton securely and mark it "FRAGILE" to assure careful handling.

Note: In any correspondence, identify the kit by number. Refer any questions to the nearest Hewlett-Packard Sales and Service Office.

20. If the card is to be stored before use, package it as described above to prevent accidental damage.

INSTALLATION MANUAL

12896A

DIRECT MEMORY ACCESS
EXTENDER ACCESSORY KIT

(FOR THE 2155A INPUT/OUTPUT EXTENDER)

Card Assembly
12896-60001, All Revisions

Note

Retain this manual with the Operating and Service
Manual supplied with the Input/Output Extender.

1. INTRODUCTION.

2. This manual provides field installation instructions for the 12896A Direct Memory Access Extender Accessory Kit, an accessory for the Hewlett-Packard 2155A Input/Output Extender. Because the kit must be used with the HP 2100 Direct Memory Access, further information about the kit is provided in both the computer documentation and the Operating and Service Manual supplied with the input/output extender. Refer to the computer Installation and Maintenance Manual (part no. 02100-90002 for 2100A or part no. 02100-90162 for 2100S), for overall principles of direct memory access (DMA) operation; refer to the input/output extender manual, part no. 02155-90002, for specific kit information such as replacement parts and supplemental theory of operation.

3. DESCRIPTION.

4. The DMA accessory kit for the input/output extender, used in conjunction with the computer DMA accessory kit, enables high-speed data transfers between computer memory and any peripheral device normally serviced through the input/output extender. Data is transferred in blocks of 16-bit words; block size can be any number between one and a number equal to the memory size of the computer. Maximum transfer rate is 1,020,000 16-bit words per second.

5. The accessory kit includes one DMA printed-circuit card, part number 12896-60001; one interconnecting cable, part number 12896-60002; and one installation manual, part number 12896-90001.

6. UNPACKING AND INSPECTION.

7. If the shipping container is damaged upon receipt, request that the carrier's agent be present when the equipment is unpacked. Inspect the card for damage (scratches, cracks, loose components, etc.). If the card is damaged and fails to meet specifications, notify the carrier and the nearest HP Sales and Service Office immediately. (HP Sales and Service Offices are listed at the back of this manual.) Retain the shipping container and the packing material for the carrier's inspection. The HP Sales and Service Office will arrange for the repair or replacement of the damaged equipment without waiting for any claims against the carrier to be settled.

8. IDENTIFICATION.

9. Printed-circuit card revisions are identified by a letter, a date code, and a division code stamped on the card (e.g., A-1103-22). The letter code identifies the version of the etched trace pattern on the unloaded card. The date code (four middle digits) refers to the electrical characteristics

of the loaded card. The division code (last two digits) identifies the Hewlett-Packard division that manufactured the card. If the date code stamped on the printed-circuit card does not agree with the date code shown on the appropriate schematic diagram in the extender Operating and Service Manual, there are differences between your card and the card described in the Operating and Service Manual. These differences are described in manual supplements available at the nearest HP Sales and Service Office.

10. INSTALLATION.

11. Install the DMA card in the extender and interconnect the DMA cards in the computer and extender according to the following procedure (refer to figure 1):

a. Halt computer and turn computer and extender power switches off.

b. Remove top access covers from computer and extender.

c. Remove card retainer from extender.

d. Insert DMA card (provided in kit) in extender slot 110. Be sure that components face left when card is viewed from front of extender.

e. Reinstall card retainer.

f. Using the cable provided in the kit, connect the DMA card in extender slot 110 to the DMA card in computer slot 9.

g. Reinstall computer and extender top access covers.

12. INSTALLATION CHECKOUT.

13. After installing the DMA accessory kit, verify proper operation by performing the DMA diagnostic test. The Diagnostic Program Procedure, part number 12578-90014, provides operating procedures for the test.

14. MAINTENANCE.

15. If the results of the diagnostic test indicate that the DMA accessory does not operate properly, refer to the Operating and Service Manual, part no. 02155-90002, supplied with the input/output extender and the maintenance documentation supplied with the computer for service information.

16. SHIPPING AND STORAGE.

17. If an item of the kit is to be shipped to Hewlett-Packard for service or repair, attach a tag to the item identifying the owner and indicating the service or repair to be accomplished. Include the number of the kit.

18. Package the item in the original factory packaging material, if available. If the original material is not available, standard factory packaging material can be obtained from a local Hewlett-Packard Sales and Service Office.

19. If standard factory packaging material is not used, wrap the item in Air Cap TH-240 cushioning (or equivalent) manufactured by Sealed Air Corp., Hawthorne, N.J., and place in a corrugated carton (200 pound test material). Seal the shipping carton securely and mark it "FRAGILE" to assure careful handling.

Note: In any correspondence, identify the kit by number. Refer any questions to the nearest Hewlett-Packard Sales and Service Office.

20. If the kit is to be stored before use, package it as described above to prevent accidental damage.
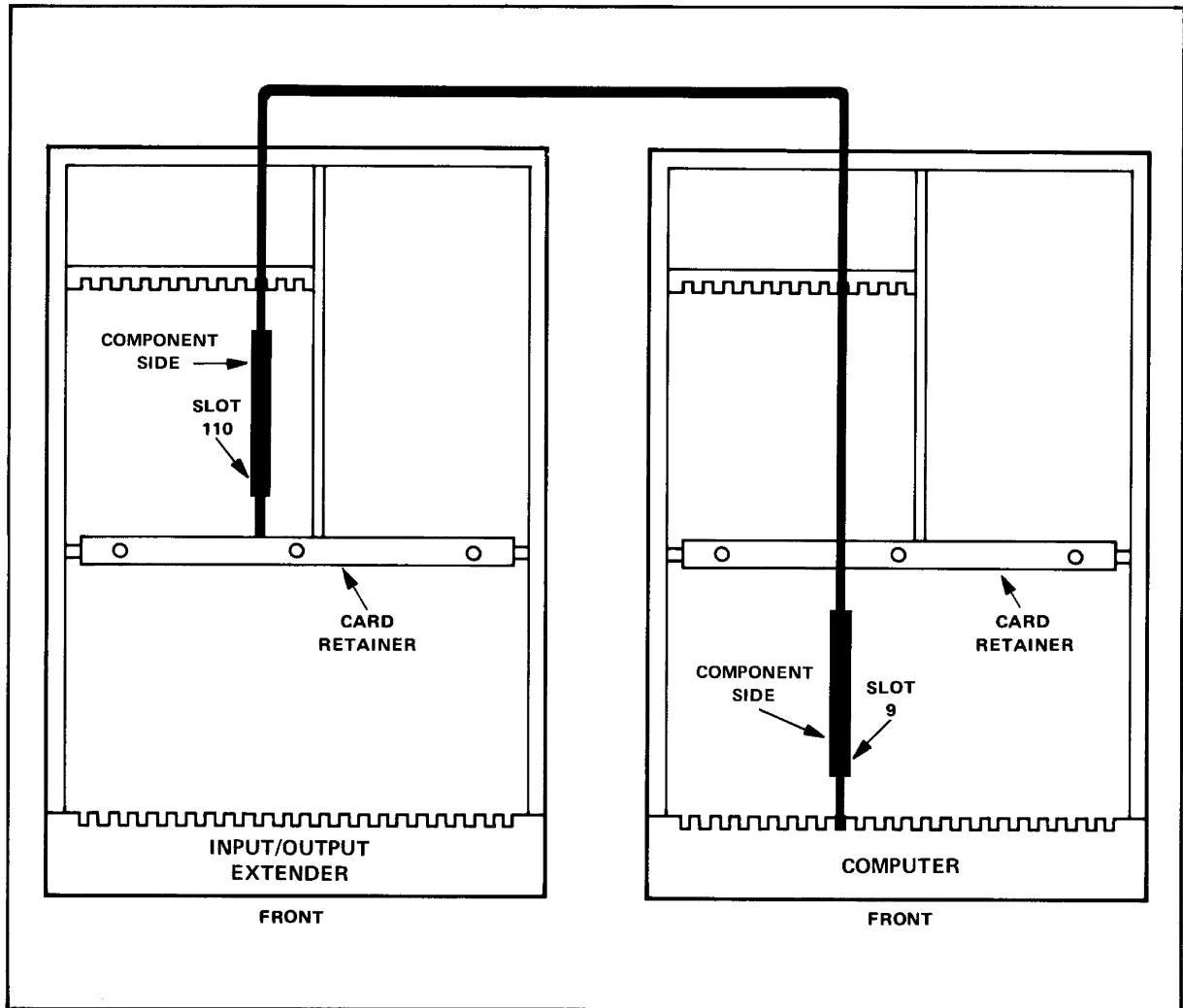
REF. 2168-1

Figure 1. Installation Details

HP 2100A DMA DIAGNOSTIC

HP Product No. HP 24195

HP 2100A DMA DIAGNOSTIC

The test program for the Direct Memory Access option can be used in two modes.
In the Long Test Mode, all functions of the DMA are tested, and any functions
specific to the select code under test are tested. The Short Test Mode tests
only the functions of the select code being tested. All select codes can be tested
by installing the proper register card in the I/O slot for the select code to
be tested and changing a diagnostic program option.

HARDWARE CONFIGURATION

This diagnostic test program runs on any HP 2100A computer with at least 4K of
memory. To test the DMA thoroughly, a Micro-Circuit Register must be used.
Although the test program can run with only a teleprinter, certain restrictions
are imposed. (See Program Limitations.) A special edge connector is required
for the Micro-Circuit Register.

The Micro-Circuit Register, HP 12566, must have the following jumper configu-
ration:

W1-B	W2-A
W3-A	W4-B
W5 through W8 - IN	
W9-A	

The special edge connector must be wired as follows:

A-1	K-9	U-17
B-2	L-10	V-18
C-3	M-11	W-19
D-4	N-12	X-20
E-5	P-13	Y-21
F-6	R-14	AA-22-23
H-7	S-15	BB-24
J-8	T-16	

Connector HP 1251-0332 can be used, with pin 22 shorted to pin 23.

FUNCTIONAL AND OPERATIONAL CHARACTERISTICS

When a teleprinter is used, the SIO teleprinter driver is loaded and configured before the diagnostic program. Then the diagnostic program is loaded and configured.

A permanent copy of the configured program (and the SIO teleprinter driver, if included) eliminates repeating the configuration steps for subsequent uses of the diagnostic. To make a copy, load the SIO System Dump program and run it before running the diagnostic program.

The Long Test Mode, selected by setting program option bit 7 off, should be done for at least one select code to check all DMA functions; using the Micro-Circuit Register the Long Test Mode requires over three minutes of run time. After operation of the DMA functions is confirmed, the remaining select codes can be checked by the Short Test Mode. In the Short Test Mode functions specific to the select code being tested are checked (SRQ lines to each DMA channel and select code lines generated by each DMA channel).

If an error is detected during operation, the program prints a message on the teleprinter, then halts with a MEMORY DATA value in the DISPLAY REGISTER. (Exceptions to this are trap cell halts $1060xx_8$ located in low memory 2_8-77_8 and halts for which a printed message is not appropriate or necessary.) The cause of any of these halts should be determined by the user before the program is run or restarted.

To repeat any test, set program option bit 13 on after an error halt then press RUN.

To reconfigure after running the program, use the re-start address 111_8 instead of the starting address 2_8.

PROGRAM LIMITATIONS

When the Micro-Circuit Register is not available, the teleprinter interface board can be used; however, 8-bit data transfers are made rather than 16-bit transfers, checking only the eight low-order bits. If the register board is used without the teleprinter, the diagnostic test program tests all sixteen

bits; but errors must be interpreted from MEMORY DATA and the contents of the A-
and B-Registers, according to Table DMA-3, after an error halt.

The Short Test Mode, consiting of tests T.17 and T.20, tests only the functions
of the select code being tested, so the Long Test Mode should be used on at least
one select code.

This diagnostic program does not check the maximum data rate specification of
the DMA.

Since each channel is tested individually, no testing of simultaneous operation
is done.

PROGRAM ORGANIZATION

This diagnostic program performs the following routines.

CONFIG   Inputs and stores hardware information supplied by the oper-
                ator through the switch register during configuration time.
                Also stores selected program options in an internal switch
                register.

INIT   Sets trap cell halts in locations 2_8-77_8 and prints the
                start-of-diagnostic message on the teleprinter.

T.1   Tests the DMA flag instructions.

T.2   Tests the ability to enable and disable the interrupt system.

T.3   Tests the DMA interrupt capability by forcing an interrupt,
                checking the return address for the correct location, and
                checking the interrupt acknowledge

T.4   Tests the control reset instructions.

T.5   If program option bit 9 is set off, tests the PRESET functions.
        Before the PRESET test starts, the program halts with 102027_8
        in the DISPLAY REGISTER, to allow the user to press INTERNAL
        and EXTERNAL PRESET.

T.6   Tests DMA interrupt priority. Checks priority of DMA channel 1
        (DMA1) over DMA channel 2 (DMA2) and over the I/O select code
        under test (which contains MCR or teleprinter interface card).
        Checks ability of DMA PH5 signal to inhibit I/O interrupts.
        Checks DMA 2 priority over I/O select code under test.

T.7   Tests the ability to set and read the word count registers
        for all numbers up to the maximum word count (65,535).

T.10   Tests the word count increment function (rollover) by setting
        the word count registers to minus one and forcing a data
        transfer which should cause the DMA to interrupt.

T.11   Tests the direct memory address registers by making DMA out-
        put transfers from every available location in memory.

T.12   Tests the ability of the DMA to set an interface control
        flip-flop when bit 15 of the DMA program control word has
        bet set to a one.

T.13   Tests the ability of the DMA to clear an interface control
        flip-flop when bit 13 of the DMA program control word has
        been set to a one.

T.14   Tests the ability of DMA generated signal to clear interface
        flag after transfer.

DMA-4

T.15   Tests the DMA output capability with all possible 16-bit
            data patterns and their complements if MCR is used, or with
            all possible 8-bit patterns and their complements if TTY
            interface is used.

T.16   Tests the DMA input capability with the same data patterns
            used in T.15

            *NOTE: The Long Test Mode (program option bit 7 set off)
                     performs all tests, the Short Test Mode (bit 7
                     set on) performs only tests T.17 and T.21.*

T.17   Used in the Short Test Mode, this routine uses subroutines in
            T.15 to output one word through each DMA channel.

T.21   Tests the DMA for illegal response to incorrect select codes.

END   If program option bit 12 is set on, END prints the end-of-diagnostic
            message on the teleprinter and halts, or if bit 12 is set off,
            END restarts the program.

            *NOTE: This END routine has provisions for return of
                     execution control to a suitable executive pro-
                     gram, if present.*

OPERATING INSTRUCTIONS

            *NOTE: This procedure presumes the use of a Micro-
                     Circuit Register. The register card must
                     have jumpers wired as described under HARD-
                     WARE CONFIGURATION and must be connected
                     through an edge connector, also described
                     in that section. If the register card is
                     not used, install the teleprinter inter-
                     face card in the slot to be tested; limit-
                     ations described will apply.*

a. Install the register card in the I/O slot to be tested. If the Long Test Mode is to be used, make sure that all I/O slots of Higher priority have either an interface card or a priority jumper installed.

b. If the test program is being run for the first time and a teleprinter is available, use the Basic Binary Loader (BBL) to load the teleprinter driver then configure the driver. Then use BBL again to load this diagnostic program. If a configured HP 2100A DMA Diagnostic tape is available, skip the following configuration procedure (steps c through f); load the configured tape using BBL, and start at step g.

> NOTE: A teleprinter driver is required for SIO System Dump.

c. Set the starting address 2_8 then press INTERNAL and EXTERNAL PRESET.

d. Set the switch register for program configuration as listed in Table DMA-1 then press RUN. The program halts with MEMORY DATA 107076_8 in the DISPLAY REGISTER.

e. Set the switch register for desired program options as listed in Table DMA-2 then press RUN. The program halts with MEMORY DATA 107077_8 in the DISPLAY REGISTER.

f. To punch a configured HP 2100A DMA Diagnostic tape, use SIO System Dump, then continue with the procedure. If a configured tape is not required, skip this step.

g. Set the starting address 100_8.

h. If program options other than those set into the internal switch register by step e are to be used, set program option bit 0 on, then set the other program option bits as listed in Table DMA-2.

i. Press INTERNAL and EXTERNAL PRESET then press RUN. The program executes according to the program options selected. If program option bit 6 is set on, the program halts with 103013_8 in the DISPLAY REGISTER. Set bits 5-0 of the switch register to the select code to be tested then press RUN.

j. If the PRESET test (T.5) is to be performed, the program halts with
    102027_8 in the DISPLAY REGISTER. Press INTERNAL and EXTERNAL PRESET
    then press RUN.

k. Upon completion of all tests, the program prints a message and/or
    halts with 102077_8 in the DISPLAY REGISTER. Turn computer POWER OFF,
    move the register card to the next select code to be tested, then
    turn POWER ON again. (If the teleprinter card has been moved, reload and
    reconfigure its SIO driver.) Begin test on new select code at step g.
    Repeat steps g through k until all select codes have been tested.

ERROR ANALYSIS

All halts display a MEMORY DATA value in the DISPLAY REGISTER. Refer to Table
DMA-3 to analyze the halt conditions, then press RUN to continue the diagnostic
program.

If a trap cell halt occurs on the teleprinter select code, change the program
option to suppress all teleprinter messages (see Table DMA-2), then restart
at location 100_8.

Table DMA-1

Hardware Configuration--Switch Register Settings

Bits	Function
0-5	Set to the Register Card (or teleprinter select code interface).
6	Set on if teleprinter is not available.
7-15	Spares.

Table DMA-2

Program Options-- Switch Register Settings

Bits	Function
0	Set on to override the internal switch register, to change a program option. This bit has no effect when set on in the internal switch register.
1-5	Spares.
6	Set on to halt at the beginning of the program, to allow entry of a new select code.
7	Set on to use the Short Test Mode, otherwise the Long Test Mode is to be used.
8	Set on if a teleprinter interface card is to be used to test the select code, otherwise the program assumes a Micro-Circuit Register card is to be used.
9	Set on to omit the PRESET test (T.5).
10	Set on to suppress non-error messages.
11	Set on to suppress all messages.
12	Set on to halt the program after a complete cycle.
13	Set on to loop on the current test instead of advancing to the next test.
14	Set on to suppress error halts.
15	Spare.

TABLE DMA-3

Diagnostic Messages

MEMORY DATA	Test	Message*		Comments
(no halt)	INIT.	HØ.	START DMA DIAGNOSTIC	Initial Message.
102001	T.1	E1.	CLF6 OR SFS6 ERR	DMA1--Test the ability to clear the flag and test the SFS instruction.
102002	T.1	E2.	CLF6 OR SFC6 ERR	DMA1--Test the ability to clear the flag and test the SFC instruction.
102003	T.1	E3.	STF6 OR SFC6 ERR	DMA1--Test the ability to set the flag and test the SFC instruction.
102004	T.1	E4.	STF6 OR SFS6 ERR	DMA1--Test the ability to set the flag and test the SFS instruction.
102005	T.1	E5.	CLF7 or SFS7 ERR	DMA2--Test the ability to clear the flag and test the SFS instruction.
102006	T.1	E6.	CLF7 OR SFC7 ERR	DMA2-- Test the ability to clear the flag and test the SFC instruction.
102007	T.1	E7.	STF7 OR SFC7 ERR	DMA2--Test the ability to set the flag and test the SFC instruction.
102010	T.1	E1Ø.	STF7 OR SFS7 ERR	DMA2--Test the ability to set the flag and test the SFS instruction.
102011	T.2	(none)		CLF Ø did not disable interrupts or SFS Ø caused a bad skip.
102012	T.2	(none)		CLF Ø did not disable interrupts or SFCØ did not skip.
102013	T.2	E13.	STFØ OR SFCØ ERR	STF Ø did not enable interrupts or SFC Ø caused bad skip.

*"H" Message is informational
"E" Message indicates an error.

MEMORY DATA	Test	Message	Comments
102014	T.2	E14. STFØ OR SFSØ ERR	STF Ø did not enable interrupts or SFS Ø did not skip.
102015	T.3	E15. NO D1 INT	Test the interrupt capability of DMA1.
102016	T.13	E16. NO D2 INT	Test the interrupt capability of DMA2.
102017	T.3	E17. D1 RTN ADDR ERR	DMA1--The return address that resulted from the interrupt is incorrect.
102020	T.3	E2Ø. D2 RTN ADDR ERR	DMA2--The return address that resulted from the interrupt is incorrect.
102021	T.3	E21. D1 IAK ERR	DMA1--Interrupt acknowledge failed.
102022	T.3	E22. D2 IAK ERR	DMA2--Interrupt acknowledge failed.
102023	T.4	E23. D1 CLCØ ERR	DMA1--CLC Ø instruction failed to reset the control flip-flop.
102024	T.4	E24. CLC6 ERR	DMA1--Test ability of CLC 6 instruction to clear the control flip-flop.
102025	T.4	E25. D2 CLCØ ERR	DMA2--CLC Ø instruction failed to reset the control flip-flop.
102026	T.4	E26. CLC7 ERR	DMA2--Test ability of CLC 7 instruction to clear the control flip-flop.
102027	T.5	(None)	Press INTERNAL and EXTERNAL PRESET switches, then press RUN.
102031	T.5	(None)	EXTERNAL PRESET failed to set DMA1 flag.

MEMORY DATA	Test	Message	Comments
102032	T.5	(None)	EXTERNAL PRESET failed to set DMA2 flag.
102035	T.6	E35. D1-D2 PRIORITY ERR	DMA1 failed to take priority over DMA2.
102036	T.6	E36. D2-IO PRIORITY ERR	DMA2 failed to take priority over I/O select code being tested.
102037	T.6	E37. D1-IO PRIORITY ERR	DMA1 failed to take priority over I/O select code being tested.
102040	T.7	E4∅. WC1 IS *xxxxxx,* SHOULD BE *xxxxxx*	Word count readback from DMA1 is different from output word. A-Register (press A) contains output word, B-Register (press B) contains input word.
102041	T.7	E41. WC2 IS *xxxxxx,* SHOULD BE *xxxxxx*	Word count readback from DMA2 is different from output word. A-Register (press A) contains output word, B-Register (press B) contains input word.
102042	T.10	E42. NO D1 INT	With interrupt system enabled, DMA1 failed to interrupt after word transfer.
103043	T.10	E43. NO D2 INT	With interrupt system enabled, DMA2 failed to interrupt after word transfer.
102044	T.10	E44. WC1 IS *xxxxxx,* SHOULD BE ZERO	DMA1 word count register was not zero when interrupt occurred. B-Register (press B) contains word count.
102045	T.10	E45. D1 INT LOC IS	DMA1 interrupted from wrong location after transfer. A-Register (press A) contains correct location, B-Register (press B) contains incorrect location.

MEMORY DATA	Test	Message	Comments
102046	T.10	E46. WC2 IS *xxxxxx*, SHOULD BE ZERO	DMA2 word count register was not zero when interrupt occurred. B-Register (press B) contains word count.
102047	T.10	E47. D2 INT LOC IS *xxxxxx*, SHOULD BE *xxxxx*	DMA2 interrupted from wrong location after transfer. A-Register (press A) contains correct location, B-Register (press B) contains incorrect location.
102050	T.11, T.15-T.17	E5Ø. D1 FLG CLR	DMA1 flag was not set after output transfer. A-Register (press A) contains program return address.
102051	T.11	E51. D1 OUT=*xxxxxx*, IN=*xxxxxx*, ADDR=*xxxxxx*	DMA1 made a bad output transfer, or is not transferring data from every memory location. A-Register (press A) contains expected output, B-Register (press B) contains read-in from MCR. Then, if a TTY is not used, press RUN.
102052	T.11	(None)	Non-TTY halt for E51 output address. A-Register (press A) contains address.
102053	T.11, T.15-T.17	E53. D2 FLG CLR	DMA2 flag was not set after output transfer. A-Register (press A) contains program return address.
102054	T.11	E54. D2 OUT=*xxxxxx*, IN=*xxxxxx*, ADDR=*xxxxxx*	DMA2 made a bad output transfer, or is not transferring data from every memory location. A-Register (press A) contains expected output, B-Register (press B) contains read-in from MCR. Then, if a TTY is not used, press RUN.
102055	T.11	(None)	Non-TTY halt for E54 output address. A-Register (press A) contains address.

MEMORY DATA	Test	Message	Comments
102056	T.12	E56. D1 CTL WRD ERR	DMA1 Bit 15 of Control Word = 1, but DMA did not set interface control flip-flop after transfer.
102057	T.12	E57. D1 CTL WRD ERR	DMA1 Bit 15 of Control Word = $\emptyset$, but DMA set interface control flip-flop after transfer.
102060	T.12	E6$\emptyset$. D2 CTL WRD ERR	DMA2 Bit 15 of Control Word = 1, but DMA did not set interface control flip-flop after transfer.
102061	T.12	E61. D2 CTL WRD ERR	DMA2 Bit 15 of Control Word = $\emptyset$, but DMA set interface control flip-flop after transfer.
102062	T.13	E62. D1 CTL WRD ERR	DMA1 Bit 13 of Control Word = 1, but DMA did clear interface control flip-flop after transfer.
102063	T.13	E63. D1 CTL WRD ERR	DMA1 Bit 13 of Control Word = $\emptyset$, but DMA cleared interface control flip-flop after transfer.
102064	T.13	E64. D2 CTL WRD ERR	DMA2 Bit 13 of Control Word = 1, but DMA did not clear interface control flip-flop after transfer.
102065	T.13	E65. D2 CTL WRD ERR	DMA2 Bit 13 of Control Word = $\emptyset$, but DMA cleared interface control flip-flop after transfer.
102067	T.15	E67. D1 OUT. GOOD=*xxxxxx*, BAD=*xxxxxx*	DMA1 made a bad output transfer. A-Register (press A) contains expected output, B-Register (press B) contains read-in from MCR.

MEMORY DATA	Test	Message	Comments
102071	T.15, T.17	E71. D2 OUT. GOOD=xxxxx, BAD=xxxxx	DMA2 made a bad output transfer. A-Register (press A) contains expected output, B-Register (press B) contains read-in from MCR.
102073	T.16,	E73. D1 IN. GOOD=xxxxx BAD=xxxxx	DMA1 made a bad input transfer. A-Register (press A) contains expected input, B-Register (press B) contains actual input.
102074	T.14	E74. D1--I/O FLG SET	DMA1 I/O Flag should be cleared by DMA after a transfer
102077	END	H77. END DIAGNOSTIC	End of diagnostic. To repeat on same I/O select code set program options and press RUN.
103000	T.3	E1ØØ. D1 IAK ERR	IAK should only clear DMA1 flag buffer, not flag.
103003	T.3	E103. DR IAK ERR	IAK should only clear DMA2 flag buffer, not flag.
103005	T.6	E1Ø5. PH5 ERR	PH5 signal did not inhibit I/O interrupts.
103012	T.14	E112. D2--I/O FLG SET	DMA2 I/O Flag should be cleared by DMA after a transfer.
103013	INIT.	(None)	Enter new select code to be tested into switch register bits 5-0 and press RUN.
103014	INIT.	(None)	Set program option bits in the switch register (Table DMA-2) and press RUN.
103015	T.16	E115. D2 IN. GOOD=xxxxx, BAD=xxxxx	DMA2 made a bad input transfer. A-Register (press A) contains expected input, B-Register (press B) contains actual input.

MEMORY DATA	Test	Message	Comments
103016	T.2	E116. D1 CLF∅ ERR	DMA1 interrupted with interrupt system disabled.
103017	T.2	E117. D2 CLF∅ ERR	DMA2 interrupted with interrupt system disable.
103020	T.7	(None)	A-Register (press A) contains data resulting from LIA ∅. Should be zero.
103021	T.21	E121. D1 SC ERR	STF 1 set the DMA1 flag flip-flop.
103022	T.21	E122. D1 SC ERR	STF 16 set the DMA1 flag flip-flop.
103023	T.21	E123. D2 SC ERR	STF 1 set the DMA2 flag flip-flop.
103024	T.21	E124. D2 SC ERR	STF 17 set the DMA2 flag flip-flop.
103025	T.21	E125. D1 SC ERR	OTA 1 set the DMA1 word count register.
103026	T.21	E126. D1 SC ERR	OTA 12 set the DMA1 word count register.
103027	T.21	E127. D2 SC ERR	OTA 1 set the DMA2 word count register.
103030	T.21	E13∅. D2 SC ERR	OTA 13 set the DMA2 word count register.
103031	T.7	E131. D1 CRS ERR	CRS did not clear DMA1 register card control flip-flop.
103032	T.7	E132. D2 CRS ERR	CRS did not clear DMA2 register card control flip-flop.
103033	T.14	E133. STF6 ERR	STR6 failed to turn off DMA1.
103034	T.14	E134. STF7 ERR	STF7 failed to turn off DMA2.

MEMORY DATA	Test	Message	Comments
103035	T.6	E135. NO I/O INT	No interrupt on I/O select code. Check PRL7 signal.
1060xx	All	(None)	Trap cell interrupt. M = memory address when interrupted, xx = trap cell location.
107074	CONFIG	(None)	Press LOADER ENABLE button to turn it off then press RUN.
107075	CONFIG & INT	(None)	The select code (switch register bits 5-$\emptyset$) is invalid. (Valid codes are $1\emptyset_8$-77_8.) Set the correct select code then press RUN.
107076	CONFIG	(None)	Set internal switch register for desired program options (see Table DMA-2) then press RUN.
107077	CONFIG	(None)	Configuration complete. Use SIO System Dump or set the starting address $1\emptyset\emptyset_8$, select desired program options, press INTERNAL and EXTERNAL PRESET then press RUN.